



Decommissioning, Fuel and Waste Programme

Imperial College Reactor Centre CONSORT Reactor Decommissioning Safety Case

Project Assessment Report ONR-DFW-PAR-15-010
Revision B
05 November 2015

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Published 01/16

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EXECUTIVE SUMMARY

CONSORT Reactor Decommissioning Safety Case

This report presents the assessment findings of the CONSORT Reactor Decommissioning Safety Case, which was submitted to the Office for Nuclear Regulation (ONR) by Imperial College (the licensee). The Decommissioning Safety Case (DSC) provides safety justification for early operations equivalent to the level of a pre-commissioning safety report (PCmSR) whilst safety of later operations is covered at a conceptual level equivalent to a preliminary safety report (PSR). The safety of later operations will be fully justified through modifications to the DSC as detailed planning for those operations is undertaken.

Permission Requested

The licensee submitted the DSC to ONR for consideration in accordance with its arrangements under Licence Condition 22. ONR has chosen to assess the submission resulting in the licensee requiring authority to proceed from ONR prior to implementation of the DSC and commencing activities under Stage 1 (Removal of In Core Removable Items).

Background

The CONSORT reactor was permanently shut down in 2012, and defueling was completed in 2014. The licensee intends to decommission the reactor leading to eventual delicensing of the site, currently planned for 2021. The DSC describes the staged decommissioning programme through to delicensing and provides assessment of the risks associated with each stage.

Having successfully defueled the reactor and removed all fuel elements from the site, the radiological risk remaining at the site is greatly diminished. The remaining radiological hazard will be removed during the early stages of the decommissioning programme, with the later stages comprising routine construction/demolition work.

Assessment and inspection work carried out by ONR in consideration of this request

ONR has considered the activities comprising the whole decommissioning programme under the DSC, recognising that much of the detailed assessment of risk will be undertaken at later dates, as is appropriate to a staged programme of decommissioning. This review determined that a single design basis fault had been identified by the licensee, associated with activities under Stage 1 of the DSC. ONR has targeted its assessment to the specific activities which comprise Stage 1; removal of in core removable items which includes the neutron start-up source, to allow a judgement to be made regarding commencement of these activities.

Matters arising from ONR's work

ONR has engaged the licensee for clarification and further information with respect to shortfalls against ONR expectations with respect to the implementation of the hierarchy of control for the design basis fault identified in Stage 1; cropping of the neutron source. The responses received from the licensee demonstrate the risks have been reduced so far as is reasonably practicable (SFAIRP).

Conclusions

ONR concludes that the licensee has adequately identified the major hazards and performed an adequate assessment of the risks associated with each stage of the decommissioning programme to enable the site to move into decommissioning.

The assessment of the Stage 1 activities concludes that the licensee has demonstrated that all reasonably practicable steps have been taken to reduce the risk to as low as reasonably practicable (ALARP).

Recommendations

The project assessment report recommends that ONR notifies the licensee of no objection for transition into the decommissioning phase and to commence activities under Stage 1 of the Decommissioning Safety Case.

The ONR Site Inspector should agree a plan of regulatory hold points with the licensee, which will enable implementation of a flexible permissioning regime and proportionate regulatory scrutiny of the decommissioning programme.

The ONR Site Inspector should continue to engage the licensee to ensure that the licensee's job specific method statements are considered to be robust, seeking further assessment by ONR, if deemed to be appropriate.

LIST OF ABBREVIATIONS

ALARP	As low as reasonably practicable
CAM	Continuous Air Monitor
CNS	Civil Nuclear Security (ONR)
DBA	Design Basis Analysis
DSC	Decommissioning Safety Case
HOW2	(ONR) Business Management System
ICIS	In Core Irradiation Samples
ILW	Intermediate Level Waste
LC	Licence Condition
LCM	Low Consequence Methodology
LEV	Local Exhaust Ventilation
LLW	Low Level Waste
ONR	Office for Nuclear Regulation
OSC	Operating Safety Case
PCmSR	Pre-Commissioning Safety Report
PSR	Preliminary Safety Report
RGP	Relevant Good Practice
RP	Radiological Protection
RPE	Respiratory Protective Equipment
SAP	Safety Assessment Principle(s)
SFAIRP	So far as is reasonably practicable
TAG	Technical Assessment Guide(s) (ONR)
TIG	Technical Inspection Guide(s) (ONR)
TQ	Technical Query

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1 PERMISSION REQUESTED

1. Imperial College (the licensee) submitted the Decommissioning Safety Case (DSC) [1] to the Office for Nuclear Regulation (ONR) for consideration, in accordance with its arrangements under Licence Condition 22 (Modification or experiment on existing plant) [2]. ONR has chosen to assess the submission resulting in the licensee requiring authority to proceed from ONR, prior to implementation of the DSC and commencing activities under Stage 1 (Removal of In Core Removable Items).

2 BACKGROUND

2. In October 2011, the licensee completed a Safety Case Extension Report to maintain validity of the Operational Safety Case (OSC) until 31 May 2015. The CONSORT reactor was permanently shut down in 2012, and defueling of the reactor of all fuel elements was completed in 2014. A further extension to the OSC was sought and at a special meeting of the licensee's Nuclear Safety Committee (NSC) on 5 May 2015, an extension to the OSC until 1 January 2016 was endorsed by the NSC [3].
3. In August 2015, ONR granted consent for the decommissioning of the CONSORT reactor, following public consultation, under the Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999 [4].
4. The licensee intends to commence decommissioning of the reactor leading to eventual delicensing of the site in 2021. The DSC describes the staged decommissioning programme through to delicensing and provides assessment of the risks associated with each stage [5].
5. Having successfully defueled the reactor and removed all fuel elements from the site, the radiological risk remaining at the site is greatly diminished. The remaining radiological hazard will be removed during the early stages of the decommissioning programme, with the later stages comprising routine construction/demolition work.
6. The licensee has categorised the DSC as a Category 2 safety case, and as such, the licensee's arrangements require the licensee to submit the DSC to ONR. The licensee's arrangements provide ONR with the opportunity to either record no objection or undertake assessment of the safety case. In the case of the DSC, ONR has chosen to assess the submission resulting in the licensee requiring authority to proceed from ONR [2].
7. Similar arrangements were utilised by ONR to exercise regulatory control during defueling of CONSORT. As such, it is considered that through appropriate engagement with the licensee, ONR pursues a regulatory strategy of flexible permissioning, exercised through enhanced monitoring and control by the site inspector [6], in accordance with ONR guidance on permissioning regimes [7].

3 ASSESSMENT AND INSPECTION WORK CARRIED OUT BY ONR IN CONSIDERATION OF THIS REQUEST

8. ONR has assessed the DSC to form a judgement of the adequacy of the staged plan at a level of detail commensurate with the status as a Preliminary Safety Report (PSR). The stage 1 activities have received more scrutiny reflecting the status for that stage as a Pre-Commissioning Safety Report (PCmSR).
9. ONR has engaged the licensee to understand the decommissioning strategy and safety case and to influence the licensee with respect to ONR's permissioning strategy for the DSC [6].

10. In addition to the assessment of the DSC undertaken by ONR, an opportunity was taken to observe a NSC meeting held to discuss the DSC, as part of a routine LC13 compliance inspection [8].
11. ONR was satisfied that the NSC operates effectively, and provides an efficient mechanism for the provision of good quality advice on technical matters. Challenge from the NSC has strengthened the safety case (eg. provision of respiratory protective equipment (RPE) during source cropping) [9, 10]. ONR was satisfied that the NSC membership is appropriate to the scope of advice required during decommissioning.

4 MATTERS ARISING FROM ONR'S WORK

12. The methodology for the assessment follows HOW2 guidance on mechanics of assessment within ONR [11]. The assessment considered guidance provided in the relevant Technical Assessment Guides (TAGs) [12] and the Safety Assessment Principles (SAPs) [13].
13. Review of the whole lifetime of the DSC determined that a single design basis fault has been identified by the licensee, which relates to potential for cropping the neutron source during its removal under Stage 1. ONR has therefore undertaken assessment targeted at the licensee's arrangements for Stage 1.
14. An initial assessment of the DSC was undertaken which highlighted shortfalls against ONR expectations, including implementation of the hierarchy of control [14]. This assessment was shared with the licensee and clarification was sought with regards to the questions raised. The responses received from the licensee [15, 16, 17] have been considered during this assessment.
15. Specialist assessment of stage 1 has been conducted by a member of the Radiological Protection specialism [18]. This assessment has received appropriate peer review and acceptance from within the Radiological Protection specialism [19].

4.1 Assessment of Decommissioning Safety Case Preliminary Safety Report

16. The licensee has identified appropriate stages in the decommissioning programme and has adequately described the overall scope and hazard identification and analysis for all stages of the DSC, at a level of depth and rigour appropriate to the information available at the current time.
17. The licensee is committed to providing further in-depth safety justifications for subsequent stages of the DSC through appropriate modifications, once the detailed design of work for those stages has been developed. ONR has provided advice to the licensee regarding Stage 2 of the DSC, highlighting areas that could potentially be strengthened during preparation of the expected modification.
18. Decommissioning programmes should be structured to remove the highest hazards at the earliest opportunity, and be adequately justified by the licensee. The control rods represent the highest radiological hazard remaining at the site. However, removal of the oscillator tube assembly must be performed before the cruciform and upper guide tubes for the control rods can be removed to allow removal of the control rods themselves.
19. The licensee has demonstrated compliance with LC35 (Decommissioning), which requires the licensee to "*make and implement adequate arrangements for the decommissioning of any plant or process which may affect safety.*" Furthermore, the licensee has demonstrated compliance with LC35(5), dividing the decommissioning into appropriate stages as defined in the DSC.

20. It is my opinion that the licensee has adequately demonstrated that the faults associated with Stages 2-7¹ are low consequence. Furthermore, I am content with the licensee's claim that the overall hazard at the site will be reduced with each subsequent stage and that later stages will mainly comprise conventional construction/demolition hazards. Radioactive waste management throughout all stages has been adequately addressed in the DSC.
21. ONR should continue to engage the licensee and agree a suite of regulatory hold points, to potentially coincide with the stages of the DSC that represent the higher hazard activities, as proposed in the regulatory strategy for the decommissioning of the CONSORT reactor [6] and suggested by the licensee [2].

4.2 Stage 1 – Removal of the Oscillator Tube Assembly

22. This stage comprises removal of the oscillator tube assembly, which comprises two hollow aluminium tubes; the oscillator tube which houses the neutron source, and the in-core irradiation samples (ICIS) tube. [REDACTED]

[REDACTED] The whole assembly is approximately 4.5m in length, with a joint approximately half way along its length.

23. The two tubes constituting the assembly are intended to be removed separately. During removal from the reactor by way of manual handling, each tube will be separated at the joint owing to headroom restrictions at the reactor top. Each section will then be monitored and manually transferred from the reactor top to an area for size reduction prior to placement in a waste container for transport off the site. Size reduction will be by way of a manually operated remote cropping tool.

4.2.1 Fault Analysis

24. The HAZOP identified 14 potential faults during Stage 1 which are recorded in the DSC fault schedule [20]. The licensee has applied a methodology to sentencing of faults whereby those with the potential to deliver a dose greater than the SAPs Target 4 threshold [13] is sentenced as a design basis fault. Any faults which do not add significantly to the total risk are screened out using a low consequence methodology (LCM) [5], an approach utilised during defueling.
25. There is a single design basis fault identified: (fault 6) cropping of the neutron source leading to accidental release of the Am/Be powder, with an unmitigated worker dose of 31 mSv. The licensee's arrangements require provision of two independent safety measures for a fault requiring design basis analysis (DBA), with a preference for engineered controls.
26. No other fault identified during stage 1 leads to an unmitigated worker dose exceeding 2 mSv; consequently these faults are dealt with via the LCM. The initiating events leading to the low consequence faults largely result from operator error.
27. In my opinion, the licensee has demonstrated suitable and sufficient fault analysis through a thorough and systematic approach to identification of fault conditions, the potential consequences thereof, and identification of control measures to protect against them. I consider that the fault schedule provides a qualitative summary of the safety functional requirements and of the protection systems identified for each fault sequence.

¹ Stages 2-7 comprise removal of the control rods and remaining reactor internals, removal of the concrete bioshield, decommissioning of the laboratories, demolition of the buildings and final site clearance to enable delicensing.

28. I raised some queries with the licensee with respect to the low consequence faults. The licensee's response to the technical query [15] provides adequate information and clarification to enable satisfactory close out of the issues with regards to the low consequence faults.
29. An incident during the defueling operations highlighted the impact of failures with respect to human performance. I consider that some additional assessment by ONR of job specific method statements may be deemed to be appropriate prior to commencement of activities under the DSC.
30. Further clarification was sought from the licensee with respect to the query regarding provision of engineered controls to protect against the design basis fault, resulting in Technical Query TQ01a [16] and TQ02 [17].

4.2.2 Identified Safety Measures for Design Basis Fault

31. The licensee has identified two independent safety measures: clear marking of the crop location and positive confirmation by the supervisor (administrative preventative control); and provision of a vacuum fitted with a HEPA filter to create a Local Exhaust Ventilation (LEV) system (engineered mitigative control). The licensee also identifies two additional safety measures, both of which are mitigative measures: operatives will be required to wear RPE during cropping and continuous air monitors (CAMs) will be located near to the cropping operation to provide audible and visible alarms if elevated airborne radioactivity is detected.
32. The licensee states that no account for the performance of the HEPA filter can be taken into consideration because the performance of the system cannot be assessed. Therefore, this safety measure cannot be claimed as a safety measure in the fault protection. The required additional safety measure is effectively provided by the RPE, which the licensee assigns a decontamination factor of 40, in line with HSE guidance.
33. The licensee claims that no reasonably practicable fully engineered safety measure can be identified. The licensee suggests that use of ventilated containment or a totally remote cropping tool is judged to require considerable cost and undue complexity for a 'one off operation'. I accept the view that complex engineered measures such as those cited would not be reasonably practicable, given the justification provided in TQ02 [16].
34. However, it was not apparent the licensee had considered whether simple engineered controls could be implemented to reduce the risk from this fault (eg guarding of cropper jaws to prevent cropping of source pocket), and further clarification was sought.
35. The licensee provided TQ01a [16] which, with the accompanying email, provides adequate demonstration that simple engineered controls have been considered by the licensee. Furthermore, the licensee has demonstrated that such controls do not provide a reasonably practicable reduction in the risk of an initiating event for this fault [16], and thus that the controls provided in the DSC reduce risks so far as is reasonably practicable (SFAIRP).
36. I consider that the administrative control requiring independent verification that the crop mark does not jeopardise the neutron source and that the cropping tool has been correctly aligned with the identified mark, is sufficiently robust, especially given the importance of the operation and the stated focus on training for this operation.

4.2.3 Radiological Protection Assessment Summary

37. The specialist RP assessment [18] considered that for all faults identified in stage 1, apart from fault 6 (cropping the neutron source), the safety measures identified are

appropriate and demonstrate that the RP risks are controlled and reduced as low as reasonably practicable (ALARP).

38. Particular attention was paid to the assertion by the licensee that provision of neutron shielding during removal of the neutron source was not ALARP because of the increased gamma dose that would be received in fitting such shielding. The RP assessment found this claim to be substantiated and accepts the position of the licensee.
39. The specialist RP assessment considered that although the safety measures identified to protect against fault 6 reduce the risk significantly, the licensee had not adequately demonstrated that the risks from this fault have been reduced so far as is reasonably practicable (SFAIRP). The specialist assessment recommends that the licensee provide adequate justification for the decision not to implement a robust engineered safety measure.
40. This recommendation has now been closed through engagement with the licensee that resulted in submission of TQ01a [16], which provides the justification sought by the specialist assessment [21].

5 CONCLUSIONS

41. This report presents the findings of ONR assessment of the CONSORT Reactor Decommissioning Safety Case.
42. To conclude, I am satisfied that the licensee has demonstrated adequate cognisance of the hazards and risks through all stages of decommissioning; the DSC adequately demonstrates that safety will be maintained throughout the programme, demonstrating compliance with LC35 (Decommissioning).
43. From ONR's assessment of Stage 1, the licensee has demonstrated a suitable and sufficient fault analysis, identifying fault sequences and control measures to protect against the faults as required. The dose assessment made as part of the fault analysis is suitable and demonstrates adequate control of dose to workers and the public.
44. It is my judgement, that the licensee has demonstrated that the risk of cropping the neutron source, the single design basis fault in stage 1, has been reduced so far as is reasonably practicable.

6 RECOMMENDATIONS

45. I recommend that:
 - ONR notifies the licensee of no objection for transition into the decommissioning phase and to commence activities under Stage 1 of the Decommissioning Safety Case.
 - The ONR Site Inspector should agree a plan of regulatory hold points with the licensee, which will enable implementation of a flexible permissioning regime and proportionate regulatory scrutiny of the decommissioning programme.
 - The ONR Site Inspector should continue to engage the licensee to ensure that the licensee's job specific method statements are considered to be robust, seeking further assessment by ONR, if deemed to be appropriate.

7 REFERENCES

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